



Assessment of Potential Toxicity of Compound 1080 from Livestock Protection Collars to Canines and Scavenging Birds

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ABSTRACT

The potential toxicity of Compound 1080 from livestock protection collars (LPCs) to canines and scavenger birds was studied. Dogs and magpies were allowed to scavenge on lamb parts contaminated by 1080 solution (10 mg active ingredient/ml H₂O) from LPCs. Toxic potential was amplified by confining test animals with lamb heads and necks tainted by up to 60 ml of solution. Two of five dogs died, but none of 25 magpies were affected. One of three dogs that survived ingested residue, 0.008 mg/kg, from lamb flesh. One of two dogs that died also ingested residue, 0.002 mg/kg, from lamb flesh; the other ate contaminated wool. Dogs showed no muscle residue. Though exposure is unlikely, dogs eating contaminated wool probably would die, but those ingesting only flesh would not, because muscle residues are low; magpies appeared to be unaffected by either type of exposure. Our high scavenger survival in severe conditions was attributed to selective feeding on exposed flesh that contained low toxic residue. LPCs, when used as required to help manage coyote predation, present small risk to canines and little or no risk to avian scavengers.

INTRODUCTION

Compound 1080 (sodium fluoroacetate) is a highly toxic chemical that can affect a wide variety of vertebrates and invertebrates (Atzert, 1971; Chenoweth, 1949; Hegdal *et al.*, 1986; Rammell & Fleming, 1978; Ward & Spencer, 1947). When Compound 1080 is used in livestock protection collars (LPCs) to help manage coyote (*Canis latrans*) predation, its use

requires that coyotes bite and puncture collars on livestock and ingest small amounts of collar contents. The process entails potential biological impact, including dead livestock with 1080 solution contaminating their anterior portions and the surrounding soil and vegetation, and dead coyotes or sheep (rare) with body residues from 1080 ingestion. This investigation focused on potential toxicity to canines and scavenger birds from consuming body tissues or wool of contaminated lambs.

Two sizes of LPCs have been developed (Connolly 1980). Small LPCs, suited best for livestock weighing under 22.5 kg (50 lb), were registered (no. 56228-22) by the Environmental Protection Agency (EPA) for use against coyotes that attack sheep and goats (Moore, 1985). In June 1993, use of a larger collar was authorized by EPA for larger sheep and goats. Both sizes consist of a black rubber bladder with 2 compartments, each holding 15 ml of 1.0% Compound 1080 solution. The rubber portion is sewn to velcro straps used for attaching the LPC to livestock throats. Coyotes that attack collared livestock usually puncture the LPC and ingest a lethal dose of toxicant (Connolly *et al.*, 1978; Connolly & Burns, 1990).

Connolly (1980) reported little if any toxicity to nontarget animals, including domestic dogs (*Canis familiaris*) and black-billed magpies (*Pica pica*), from small LPCs used in field studies and pen tests. In a study unrelated to LPCs, Koenig and Reynolds (1987) reported that yellow-billed magpies (*Pica nuttalli*) poisoned by 1080 rodenticide baits required exceptional effort to locate because many were in nests high in trees or in otherwise obscure places. To avoid such difficulties, that would be characteristic of field evaluations of LPC use, we used captive subjects for which the results of exposure to potential toxicity could be determined with certainty.

We used dogs and black-billed magpies to assess toxic effects of LPC solution on skin and wool and in flesh of lamb carcasses. Increased information about dogs and magpies was desirable because their LD₅₀ values show high sensitivity to 1080 (Tourtellotte & Coon, 1951; Burns & Connolly, 1992), and they represent canine and scavenger-bird groups that are potentially exposed to 1080 during LPC use. Potential danger to test animals was increased by confining them with only heads and necks of carcasses contaminated by up to 60 ml of LPC solution, twice the amount approved by EPA in LPCs.

METHODS

Five large lambs (25–45 kg) were each fitted with a large LPC containing 60 ml (2, 30 ml compartments) of 1.0% LPC solution (10 mg active

ingredient 1080 and 5 mg rhodamine B/ml H₂O). Each compartment was punctured with a scalpel, leaving a 1 cm slit in the side placed against the lamb to provide dermal contamination. The lambs were placed on improved pasture in a 1-ha pen and had a continuous water supply. Tissue samples were collected from animals that died from exposure to LPC solution or that were euthanatized with T-61 solution when post-exposure observation ended. The lambs were observed at least daily until they died or until 7 days had passed. After exposure, lamb heads and necks with punctured LPCs and 1080 contamination were offered to dogs and magpies. The heads and necks were frozen, then thawed for testing.

Test dogs were obtained from an animal shelter where they had been scheduled for euthanasia. They were maintained in individual, chain-link kennels (2.6 × 1.4 × 1.9 m) with concrete floors for several days before tests. Floors were cleaned daily and dogs were fed daily a commercial mink feed (MF) from Fur Breeders Agri Co-op, Logan, UT, when not in test feedings. Shelter and water *ad libitum* were provided. Each dog was offered contaminated lamb parts and fed at will until its behavior indicated no interest in continued feeding. Dogs were observed daily for 7–9 days post-test for signs of intoxication.

Magpies trapped on the research site were held in groups of five in kennels (3.7 × 1.2 × 1.8 m) with sheltered perches and water available continuously, and were fed MF daily when not in tests. Each group was held for 6 days or more to adjust to captivity, for 6–7 days to test, and for 6–7 days to observe post-test. Groups of five magpies each were offered lamb heads and necks that had been used in a dog test, soon after the test ended. A control group of five magpies, fed MF daily, was maintained simultaneously with groups of test birds.

Test and control animals were inspected at least daily to observe their health and detect possible signs of 1080 intoxication. In mammals, signs of intoxication vary from progressive depression to violent epileptiform convulsions and death (Ward & Spencer, 1947) and include respiratory, central nervous system and muscle effects shown by dyspnea, ataxia, weakness, tremors, convulsions, and increased salivation, urination and defecation (Hudson *et al.*, 1984). Also, vomiting is an early characteristic sign in some animals (Atzert, 1971). Magpies show a progression of apparent nervousness, lethargy, ataxia, recumbency, seizures and death. Lethargic birds sometimes remain motionless with eyes closed and feathers fluffed for up to several hours (Burns & Connolly, 1992).

Tissue samples from animals that died following test exposure were collected and analyzed for 1080 residue (Okuno *et al.*, 1982) at the Denver Wildlife Research Center (DWRC) using a Hewlett-Packard Model 5880A gas chromatograph with a SPB-1 (30 ml) capillary column.

The Compound 1080 was purchased from Tull Chemical Co. Inc., Oxford, AL and contained at least 90% sodium monofluoroacetate. LPCs were purchased from Ranchers Supply, Alpine, TX. Mention of commercial products in this paper does not imply endorsement by the US Government.

Studies were conducted at the DWRC Predator Research Site, Logan, UT, between September 1981 and April 1982. Only healthy animals from clean environments were used.

RESULTS

Three lambs died after ingesting 1080 from leaking collars. The two others received only dermal exposure and survived; they were euthanatized after 7 days of exposure. The 1080 oral and dermal toxicity, and 1080 residue recovered from sheep muscle were reported elsewhere (Burns & Connolly, 1995a).

Five dogs that weighed an average of 10.9 kg [range (ra) = 8.2–13.6] fed on the contaminated head and necks for an average of 31 min (ra = 20–50), and consumed an average of 0.71 kg (ra = 0.23–1.14) of flesh (Table 1). The dogs fed mostly on flesh exposed at cuts where the heads and necks had been removed from carcasses, and no dog muscle showed detectable residue.

Survival of dogs varied. Dogs 1, 3, and 4 survived and showed no

TABLE 1
Dog Feeding on Necks of Lambs Exposed to LPC Solution from Livestock Protection Collars and Residue Detected in Sheep Neck Muscle

<i>Dogs</i>				<i>Sheep</i>	
<i>Number</i>	<i>Weight (kg)</i>	<i>Feeding time (min)</i>	<i>Amount eaten (kg)</i>	<i>Number^a</i>	<i>Neck muscle residue (ppm)^b</i>
1	8.2	50	0.23	1	0.28
2	13.6	NR ^c	0.45	2	0.05
3	11.8	25	1.14	3	TR ^d
4	10.0	20	0.80	4	ND ^c
5	11.6	28	0.91	5	ND

^aSheep 1–3 died from ingesting 1080 from LPCs, sheep 4 and 5 had only dermal exposure to LPC solution.

^bAverage of duplicate analyses of a muscle sample.

^cNot recorded — dog was left unobserved with sheep parts for 120 min.

^dTrace amount of residue detected; not quantifiable.

evidence of intoxication. Dog 1 consumed an estimated 0.008 mg/kg of toxic residue containing 0.28 ppm from sheep 1. Dog 3 consumed flesh with unquantifiable traces of 1080 from sheep 3 and dog 4 consumed flesh with no detectable 1080 from sheep 4. Dogs 2 and 5 died. Dog 2 consumed an estimated 0.002 mg/kg of toxic residue containing 0.05 ppm from sheep 2 and died about 36 h post-exposure. The amount of toxicant consumed should not have been lethal, and the exceptionally long time to death post-exposure suggested that dog 2 ate additional contaminated material from its kennel after the head and neck were removed and observations had ceased. The kennel-pen configuration required that one pass through the kennel when removing contaminated sheep parts from the observation pen. Dog 5 ate bloody wool with its meal and died between 8 and 12 h later, a time frame typical of low 1080 doses.

When 25 magpies were exposed to the same contaminated heads and necks as the dogs, none died, no signs of toxicity were observed, and magpie tissues were not examined for toxic residue. Magpies consumed the eyes and exposed flesh on lamb necks and apparently consumed little, if any, LPC-solution contaminated material.

DISCUSSION

Dogs that might find and feed on 1080-contaminated wool or other material around sheep or lamb carcasses would probably die, but there is little danger to dogs that eat only flesh of dead livestock that consumed LPC solution, because of low toxic residue. Dogs that ingested lamb flesh consumed only about 3–13% of an LD₅₀ (0.66 mg/kg, Tourtellotte & Coon, 1951) for 1080 in dogs. Moreover, dog exposure to dead lambs contaminated with LPC solution is improbable; there has been only one reported lamb accidentally killed during extensive field use of LPCs (Walton, 1992). Lack of muscle residue from exposed dogs and time to death after exposure in dog 5 indicated that dogs consumed no, or only small amounts of, 1080 despite the hazardous test conditions.

Although magpies are very sensitive to 1080, they appear relatively safe from sheep contaminated with LPC solution because, like most dogs, they fed primarily on exposed flesh that had low toxic residue. High survival of magpies reinforced observations by Connolly (1980) that magpies were not affected when scavenging LPC-contaminated lambs.

Other investigators have indicated that LPC use presents little or no hazard to various scavengers. Burns and Connolly (1995b) observed signs of intoxication, but no deaths in golden eagles (*Aquila chrysaetos*) and no signs or deaths in skunks (*Mephitis mephitis*) and magpies exposed to LPC

solution on actual and simulated coyote kills; they also reported no intoxication or death in skunks and magpies fed tissues and vomitus of coyotes killed by LPCs. Skunks and golden eagles survived on diets containing quantities of 1080 higher than toxic residues from LPC-killed coyotes (Burns *et al.*, 1991). Eastland and Beasom (1986) indicated that poisoning was unlikely in raccoons (*Procyon lotor*), opossums (*Didelphis virginiana*) and skunks from coyotes killed by 1080 from toxic collars (LPCs).

Our study supports recent reports (Connolly, 1993; Walton, 1992), indicating lack of effect on nontarget species during extensive field use of LPCs. High survival under our test conditions in sensitive test species indicates some risk to canids and little or no risk to avian scavengers from normal use of 1080 in LPCs.

ACKNOWLEDGEMENTS

We thank the US Fish and Wildlife Service for partial funding support, I. Okuno for chemical analyses, and M.W. Fall, F.F. Knowlton and L.A. Windberg for helpful comments on the manuscript.

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